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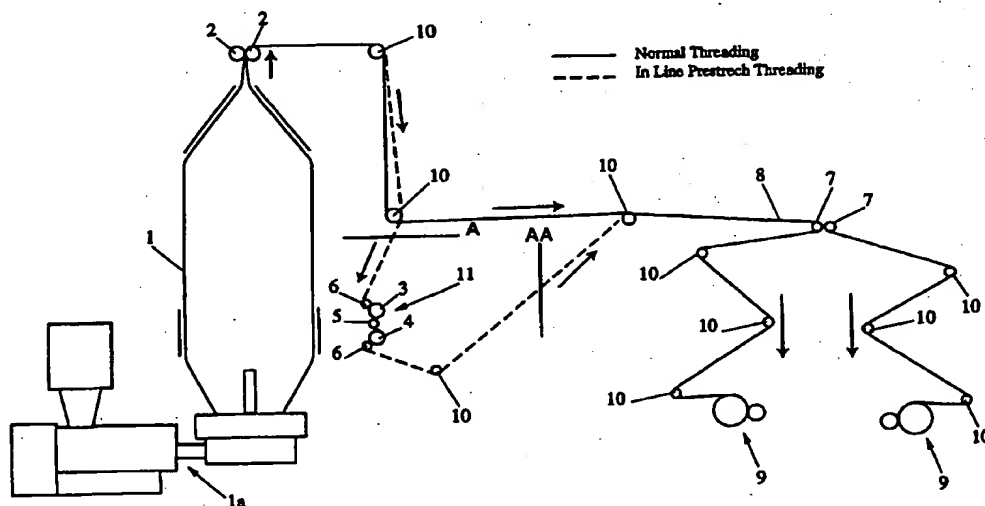
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(54) Title: METHOD AND APPARATUS FOR PRODUCING STRETCH WRAP PLASTIC FILM



(57) Abstract

The present specification discloses a plastics material film (1) that is stretched beyond its yield point to about 100 % to 400 % elongation and thereafter only partially relaxed to release part of the elastic deformation component in the film to retain between about 20 % and 80 % of the elastic deformation in the film (1), the film thereafter being stored in this partially relaxed state whereby, when it is used, the retained elastic deformation capability is useable for the intended purpose of the film, for example, wrapping a load.

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**METHOD AND APPARATUS FOR
PRODUCING STRETCH WRAP PLASTIC FILM**

The present invention relates to a method and process for producing stretch wrap plastic film and in particular, the storage of such plastic film which
5 has undergone stretching prior to storage on a roll.

SUMMARY OF PRIOR ART

In German laid open specification P3409117 there is disclosed a process for wrapping packaged goods in a web shaped stretch film wherein the film is provided in an already stretched state rolled up under tension; with the
10 stretching taking place during the actual manufacture or as an intermediate step after processing of the film. In other words, in any film that has been stretched before storage, it is possible to store the film in its tensioned stretch state without allowing it to relax.

In this way, it is possible for the film to do work so that the retained tension
15 in the film will act on a load or package with the film relaxing to a steady state when wrapped around a load or package. In the arrangement disclosed, it is necessary to avoid over stretching of the film and it may be necessary to apply adhesive to the stored film to avoid unwinding or recoiling of the film. Furthermore, it has been found that the relatively high stored tension in the roll
20 may cause the core of the roll to collapse.

In Australian Patent No. 643902 there is disclosed a method and apparatus for making pre-stretched film from molten stock material, cooling the film, stretching the cooled film beyond the yield point and substantially relaxing the film to reduce the tension therein. It is disclosed that the major benefit
25 achieved by this method and apparatus is that the film has been cold-oriented and relaxed to obtain a reduced web thickness and that the film does not need to be stretched as it is applied to an external configuration such as a load to obtain any savings of material. The film has merely to be tightened around a load upon application thereby providing better load containment than similar
30 hand wrapped applications of prior art films.

In Australian Patent Application No. 55564/94 there is disclosed the provision of a roll of stretched plastics material film which has an embossed surface for trapping air so as to facilitate unwinding of the roll of stretched film for wrapping pallet loads. The film is totally relaxed prior to winding on to the
5 storage roll.

SUMMARY OF THE INVENTION

The present invention seeks to minimise the perceived disadvantages of the known prior art and has as its primary objective the provision of a method and apparatus for making stretched film product wherein the film is pre-stretched
10 to provide a predetermined significant amount of memory, i.e. elastic deformation or recoverable strain in the film as distinct from non-recoverable plastic deformation of the film.

Preferably the stretching of the film is carried out at the point of manufacture of the film in an extrusion machine so that the film is stored for later
15 use in a stretched condition or at least partially stretched condition. During or after stretching and prior to storage it is necessary to trim the edges of the film to remove distortion at the marginal edge portions of the film which tend to form thickened areas compared with the main body of the stretched film web.

In a specific aspect of the invention, the amount of recoverable strain
20 retained in the film falls within the range of about 20% to a maximum of about 80% of the total memory in the film.

The lower limit represents the minimum amount of useable stretch being retained for effective wrapping of a load and the upper limit represents the maximum amount of stretch that can be retained and yet avoiding damage to
25 supporting cores and telescoping of the film during storage.

In one specific aspect of the invention the film is produced as a tube in an extruder of known construction and procedure and after cooling is stretched prior to cutting the tube to form webs of predetermined width and at predetermined retained memory in the stretch procedure which can then be
30 stored for later re-use.

The present invention also anticipates providing a stretch plastics material film made by any of the aforesaid methods.

In one preferred aspect of the present invention there is provided a method of making stretch film including the steps of stretching the film beyond its yield point to an elongation greater than 100%, removing opposed edge zones of the stretched film to produce a film having a substantially uniform thickness, allowing the film to partially relax to release part of the elastic deformation component in the film to retain between about 20% and 80% of the elastic deformation, and storing the partially relaxed film for future use in the partially relaxed state.

In another aspect of this invention there is provided a method of wrapping a load with plastics material film including providing plastics material film stretched beyond its yield point which in a stored state retains between 20% and 80% of the film's elastic deformation capability, and thereafter wrapping said film about said load. The load may be any product or material that requires wrapping but can include pallet wrapping, vegetation material during the production of silage, and bundle wrapping applications such as timber lengths, cans including drink cans and any other similar product. Wrapping of the load may be achieved by storing the plastics material on a roll capable of use in either a manually handled wrapping machine, or a powered wrapping machine of any conventional configuration. The advantage achieved is that the force required to establish a required elastic loading on the load to be wrapped is substantially reduced because of the retained elastic deformation levels in the plastics film.

In a still further aspect of this invention there is provided a method of dispensing a plastics material film including providing a plastics material film stretched beyond its yield point which in a stored state retains between 20% and 80% of the film's elastic deformation capability, and thereafter dispensing said film from the stored state.

Conveniently in both the preceding aspects, the plastics material film prior to being stored in said stored state is stretched beyond its yield point in the range of about 100% to 400% elongation.

The invention will now be described in greater detail with reference to examples and a preferred embodiment shown in the accompanying drawings in which :-

Figure 1 shows schematically a stretch film production machine using an extrusion method, and a means for modifying this conventional arrangement to achieve in-line stretching of the film;

Figure 2 shows in side elevation details of apparatus for stretching plastics material film as may be used in this invention; and

Figure 3 shows schematically a non-in-line arrangement for stretching plastics material film in accordance with this invention.

With reference to Figure 1, an extruder 1(a) operates in known manner to generate an inflated film "bubble" 1 which is drawn up from the extruder to a great height in a cooling phase and then passed through a primary nip formed by nip rollers 2 to collapse the "bubble" whence it is passed to a secondary nip formed by nip rollers 7 via a film trimming and/or splitting station 8 or alternatively, to a stretching station A-AA comprised of several stretching and, if desired, web width adjustment rollers.

The extrusion line including the extruder 1(a) operates in a substantially continuous manner as a blown film line where film is fed to the secondary nip rollers 7 running at approximately the same speed as the primary nip rollers 2.

There may be in some instances as desired, a slight relaxation of the film between the primary top nip rollers 2 to film winding rollers 9 located after the secondary nip rollers 7 of between 1% to 2% to reduce any tension in the film during the winding process.

The tube may be separated with the two external edges of the film being trimmed when passing the trimming station 8 at or just prior to the secondary nip rollers 7 to form two separate film sheets. Further film splitting can occur at station 8 or subsequently prior to the film winding rolls 9 to provide differing film strip widths.

In accordance with one preferred aspect of the present invention, an in-line stretching unit 11 is provided as shown at A-AA of Figure 1. The unit 11 may be interposed after the primary nip rollers 2 and before the secondary nip

rollers 7 as shown. Thus, the stretch unit may be an optional add on feature of a conventional extrusion machine and the unit is suitable for dual operation with or without in-line stretch of the film.

In operation of the in-line stretch unit the film is threaded around the low speed stretching roll 3, the high speed stretching roll 4 and then back to the idler rolls 10 and thence to the secondary nip rollers 7. With reference to Figure 2 of the drawings, the idler nip rolls 6 in the stretch unit are adjustable to an open position 6(a) to allow easy threading of the film therethrough. The nip rolls 6 may be left in the open disengaged position 6(a) whilst the extruded "bubble" of film is established and correct film thickness of say 25 microns at a lay flat tube width of 1,900 mms is produced. The idler roll 6 can then be moved to the closed or engaged position with the low speed stretch roll 3 and the high speed stretch roll 4.

A web width adjustment roller 5 may also be provided which is adjustable between various positions, for example as shown at 5(a). The adjustment is dependent upon the amount of "neck down" imparted to the film which in turn impacts directly upon the properties of the stretched film.

In accordance with a further preferred aspect of this invention there is provided a non-in-line stretching unit which may take a roll of plastics material stretch film 9 such as might be produced by a conventional extrusion line shown schematically in Figure 1 and at any time there after stretch same as illustrated schematically in Figure 3. The film is passed through a stretching unit 11 which may be similar to that shown in Figures 1 and 2. The unit 11 includes a low speed roller 3 and a high speed roller 4 with stretching of the film 9 beyond its yield point generally occurring between these two rollers. The secondary nip rollers 7 are driven at a speed similar to the high speed roller 4 with partial relaxation occurring between the rollers 7 and a wind-up roller 19 such that partial elastic deformation in the range of between 20% and 80% is retained in the film. Stretching of the film beyond its yield point has been found to create a non-uniform thickness transversely across the width of the film web. More particularly thickened edge portions are created with a wide central zone of substantially uniform thickness reduced from the thickness of the film before

stretching. Thickened edge zones make it quite difficult for such film to be wound up onto a roll and therefore, a preferred aspect of this invention is to remove these thickened edge portions to provide a film web of substantially reduced and uniform thickness across its width. To this end a cutting station 18 is provided to remove the edge regions of the stretched film. If it is desired to cut the film into a number of strands of different widths, this may also occur at the cutting station 18 or at a subsequent cutting station before the wind-up roller 19.

The pre-stretching process will be described with reference to the following examples when having reference to the accompanying Figures 1 and 2 wherein the plant is operating as already described above.

EXAMPLE 1

The approximate speed of the film travel is 100 metres per minute producing a 25 micron film thickness at a lay flat tube width of 1,900 mm. The primary nip rollers 2 and the low and high speed stretch rollers 3, 4 initially are operated at the same speed of approximately 100 metres per minute. In this format, the tube is wound on the wind up rolls 9 after the edges are trimmed at edge trim station 8.

The stretching operation can now be commenced with the low speed stretch roller 3 maintaining a similar speed as primary nip rollers 2 and the high speed stretch roller 4 and following secondary nip rollers 7 and the winding rollers 9 accelerating to the desired speed to achieve the predetermined amount of stretch and relaxation desired. To ensure correct levels of stretch and relaxation it may be preferable to measure the actual film speed rather than roller speed to guard against the effects of any film slippage on the rolls. For example, pre-stretching the film to 200% elongation with approximately 50% of elastic deformation being left on the roll is achieved by accelerating the high speed roller 4 to 300 metres per minute with the film winding roller 9 being accelerated to a lesser extent of approximately 270 metres per minute. The formula to achieve the correct speed of the winding roller 9 is as follows :-

$$100 \text{ metres / minute} + (200 \text{ metres / minute} \times 85\%) = 270 \text{ metres / minute.}$$

Given that 30% of total deformation (200%) of the plastics material is elastic or recoverable if the film is relaxed, this represents a 50% relaxation of

the film as it is wound on to the film winding roller 9. Putting it another way, the film is stored with 50% of the elastic deformation of the film still available to do work or to be released. Obviously the stretched film may be further elongated at this stage.

- 5 When a film is stretched 200% that is :-
1m to 3m

Total Deformation : 2m

which is divided between plastic deformation and elastic deformation.

Therefore,

- 10 Total Deformation = Plastic deformation and elastic deformation.

In the above case :

Plastic Deformation : 70%

Elastic Deformation : 30%

- 15 It will be appreciated that these ratios may vary without departing from the scope of the invention.

Therefore, to achieve a stretch film storage with the above parameters, requires roll speeds as follows :-

- Primary nip rollers 2 : 100 metres / minute
Low speed stretch roller 3 : 100 metres / minute \pm 1 - 2%
20 High speed stretch roller 4 : 300 metres / minute
Film winding roller 9 : 270 metres / minute

- 25 Furthermore, it will be feasible to use the secondary nip roller 7 at slightly less than 270 metres per minute to create tension through the winding roller 9 to minimise possible production problems of film wrap around in the wind up of the film.

EXAMPLE 2

- Primary nip rollers 2 : 70 metres / minute
Low speed stretch roller 3 : 70 metres / minute
High speed stretch roller 4 : 245 metres / minute giving a 250%
30 elongation
Secondary nip rollers 7 : 215 metres / minute giving a 207% elongation

Film winding roller 9 : 218.75 metres / minute giving a final elongation of 212.5%.

With control of the film speed parameters, it is possible to have elastic deformation retained in the range of about 20% to about 80% with the upper limit depending upon the core used to store the rolled film. It has been found that retained elastic deformation in the range of 40% to 60% provides excellent results.

It is possible to produce pre-stretched rolls at varying widths as follows :-

- (a) Producing full width pre-stretched rolls as described which are transferred to a secondary re-winder (not shown) and slitting the rolls to required width and then re-winding to an appropriate length, for example 400 metre hand rolls and 2,000 metre machine rolls at a width of 500 mm.
- (b) Producing a full width pre-stretched lay flat tube re-winding the dual webs after separation of the two webs and winding each web at a separate re-wind station out of line after trimming of the edges.
- (c) Producing a single or dual or lay flat tube unstretched on line and then automatically stretching on to a re-winder to produce rolls as in (a) or (b).

It has been found that utilising pre-stretched film that has been only partially relaxed will achieve the same wrapping forces on a load but requires less force to be applied to the film thereby minimising the possible tearing or puncturing of the film in the stretch application. That is, less force is required to be applied to the pre-stretched film than if it has been totally relaxed or not pre-stretched.

For example, a 1 metre to 3 metre stretch relaxed to 2.7 metres and then stretched back to 3 metres requires force X.

1 metre to 3 metre stretch relaxed to 2.4 metres (totally relaxed) to stretch back to 3 metres requires a force of X plus Y which force is greater than force X.

Production of partially relaxed film will impart greater versatility and breadth of application to various loads.

Such a partially relaxed film may be wrapped around a desired product or load without further stretching at the point of wrapping and in which case the retained elastic capability can be used to provide the required retaining force for

the load. A partially relaxed film in accordance with the present invention may be further stretched (or restretched) to attain the original level of stretching or in some cases even beyond the original level of stretching but this will require more force than that which would have been required during the original
5 stretching process.

The stretched film can be used in various non wrapping applications, for example police tape where tension in the film would be a clear advantage.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A method of making stretch film which is stretched beyond its yield point while retaining an elastic deformation component in the film, said method including the steps of stretching the film in the range of about 100% to 400% elongation, allowing the film to partially relax to release part of the elastic deformation component in the film to retain between about 20% and 80% of the elastic deformation, and storing the partially relaxed film for future use in the partially relaxed state.
2. The method as claimed in Claim 1, wherein the film is stored retaining between 40% and 70% of the elastic deformation.
3. The method as claimed in Claim 1 or Claim 2, wherein said stretching in the range of 100% to 400% and subsequent partial relaxation occurs in-line.
4. The method as claimed in any one of Claims 1 to 3, further including the step of trimming edges of the stretched film to remove marginal edge distortion in the film during or after the stretching process prior to storage.
5. A method of making stretch film including the steps of stretching the film beyond its yield point to an elongation greater than 100%, removing opposed edge zones of the stretched film to produce a film having a substantially uniform thickness, allowing the film to partially relax to release part of the elastic deformation component in the film to retain between about 20% and 80% of the elastic deformation, and storing the partially relaxed film for future use in the partially relaxed state.
6. A method of making stretched film wherein the film web is produced in an extrusion machine and after cooling is stretched prior to removing the web / webs and slit if required to form at a predetermined retained memory in the stretch procedure and storing the film for later use.

7. A stretch film made in accordance with the method claimed in any one of Claims 1 to 6.
8. A method of wrapping a load with plastics material film including providing plastics material film which in a stored state retains between 20% and 80% of the film's elastic deformation capability, and thereafter wrapping said film about said load.
9. A method of wrapping vegetation material to form silage, said method including providing plastics material film which in a stored state retains between 20% and 80% of the film's elastic deformation capability, and thereafter wrapping said film about said vegetation material.
10. A method of dispensing a plastics material film including providing a plastics material film which in a stored state retains between 20% and 80% of the film's elastic deformation capability, and thereafter dispensing said film from the stored state.
11. A method according to any one of Claims 8 to 10, wherein said plastics material film prior to being stored in said stored state is stretched beyond its yield point in the range of about 100% to 400% elongation.

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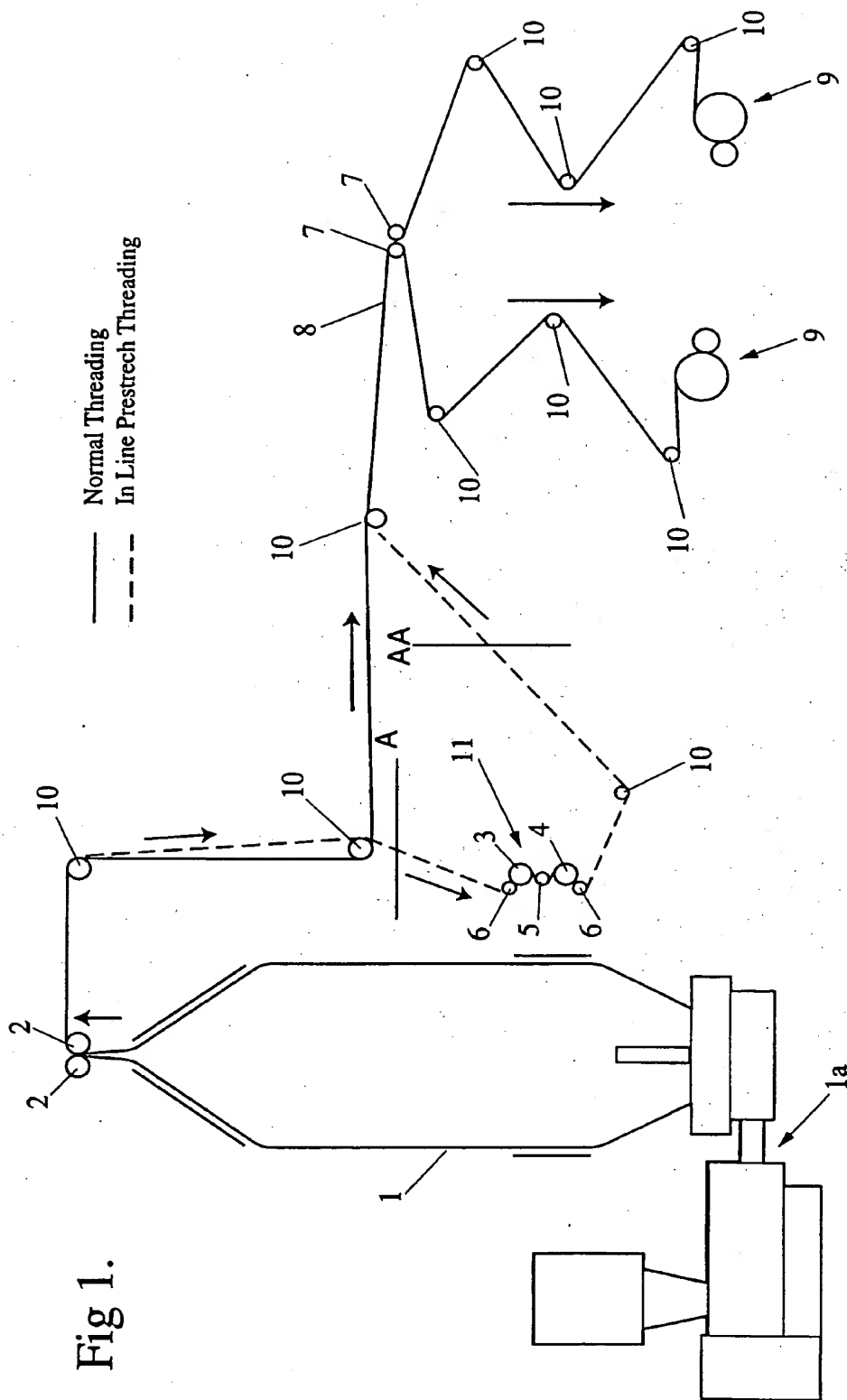
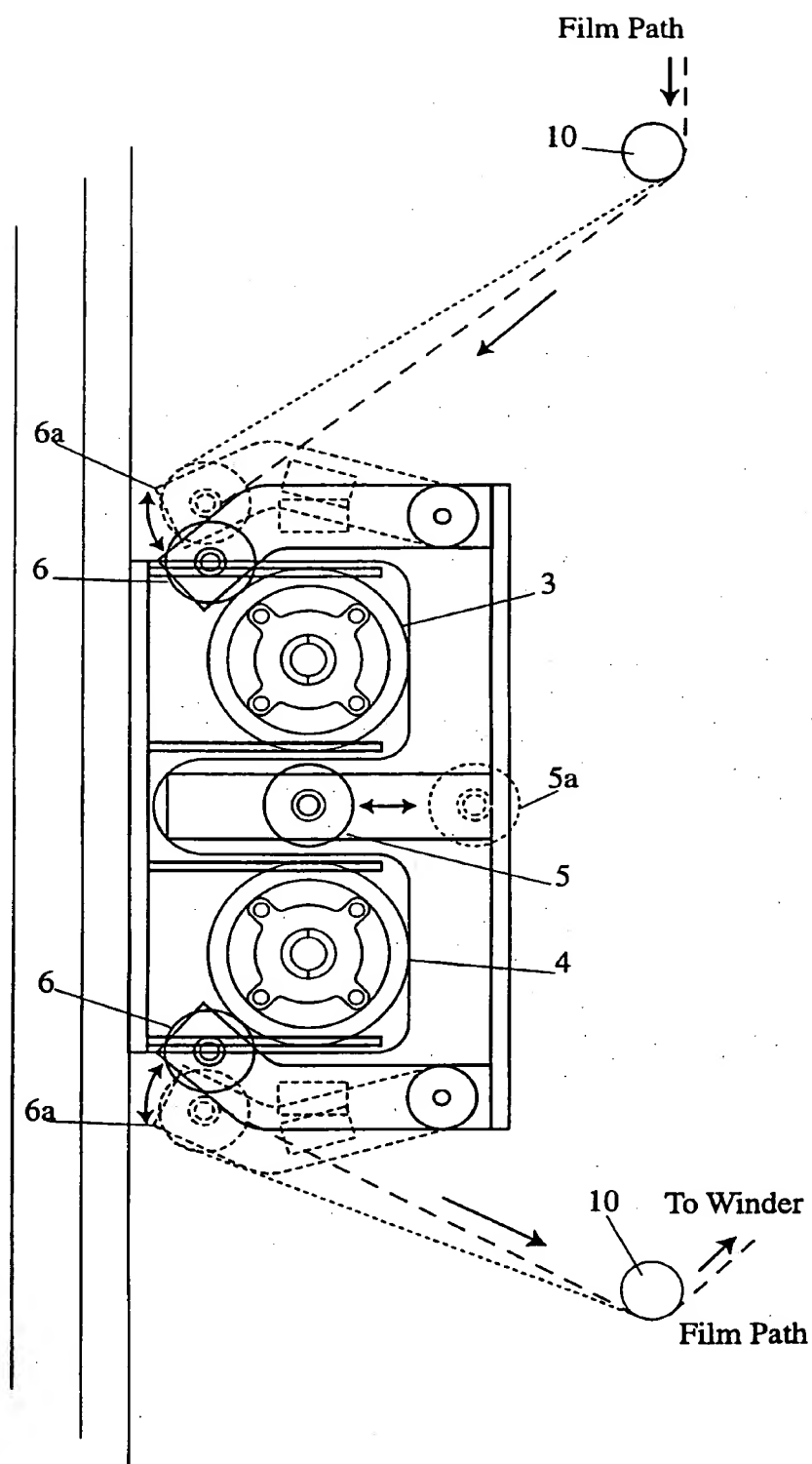


Fig 1.

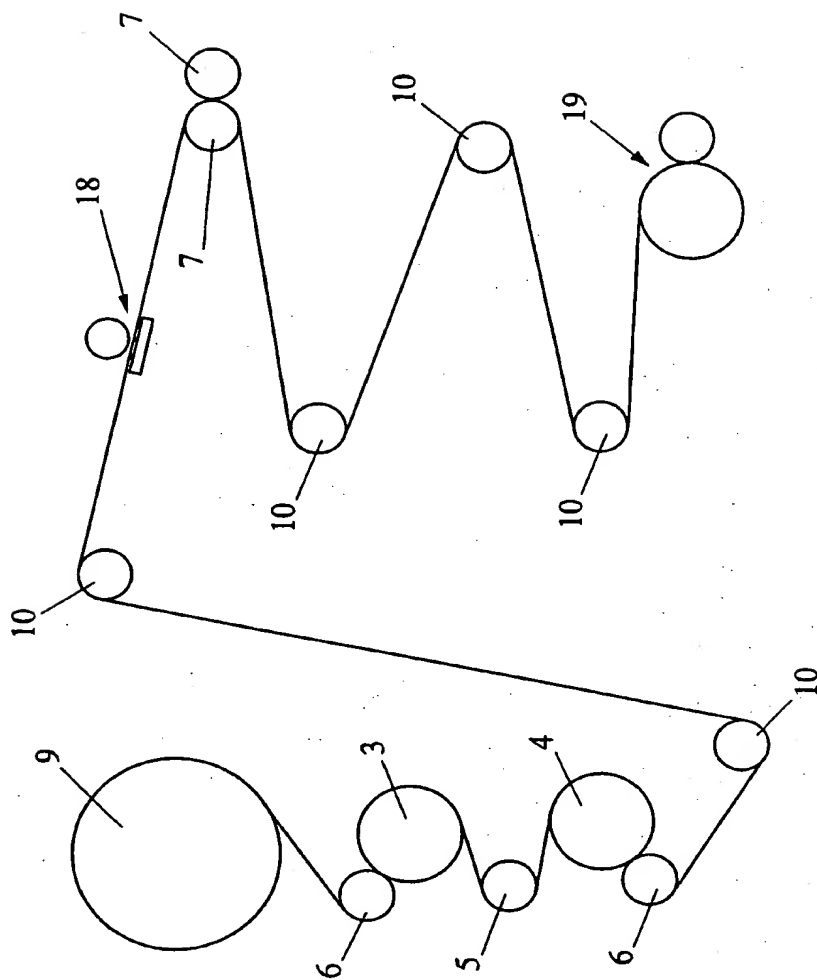
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Fig 2.



3/3

Fig 3.



INTERNATIONAL SEARCH REPORT

International Application No.
PCT/AU 98/00314

A. CLASSIFICATION OF SUBJECT MATTER												
Int Cl ⁶ : B29C 55/02; A01F 25/13												
According to International Patent Classification (IPC) or to both national classification and IPC												
B. FIELDS SEARCHED												
Minimum documentation searched (classification system followed by classification symbols) B29C 17/02; B29C 55/00; A01D 37/00, A01D 39/00, A01D 59/00; A01F 25/13; A23K 3/02; B65B 61/00												
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched												
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) DERWENT: IPC as above + (redax: or recover:) and (elastic) + ("stretch film" or "shrink film" or "stretch JAPIO: wrap" or "shrink wrap") and (store: or roll or reel)												
C. DOCUMENTS CONSIDERED TO BE RELEVANT												
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.										
X	AU,B 19501/92 (643902) (ILLINOIS TOOL WORKS) 11 March 1993 See page 4 lines 31-36, page 10 lines 1-20 and page 13 lines 3-8	1-11										
X	AU 55564/94 A (SALTECH INC) 6 June 1995 See page 2 last paragraph, page 6 paragraph 3	1-11										
X	US 4436888 (LOPPLE) 13 March 1984 See claim 1, column 1, paragraph 1, see abstract	1-11										
<input type="checkbox"/> Further documents are listed in the continuation of Box C <input checked="" type="checkbox"/> See patent family annex												
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Patent Document Cited in Search Report				Patent Family Member			
AU,B	19501/92	CA	2071422	EP	531021	JP	5208443
		NZ	244093	ZA	9205020	US	5458841
AU	55564/94	CA	2068908	WO	95/13965	EP	728102
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